Scientific Sleuthing Helps Clear TCK Trade Hurdles

Gary L. Peterson holds a test tube out in front of him and taps it with his fingers, causing a black liquid inside to swirl about.

The cloudy liquid is actually the spores of a fungus called *Tilletia controversa* Kuhn (TCK). In the United States, TCK sporadically infects winter wheat crops in the Pacific Northwest, notes Peterson, a biologist with ARS' Foreign Disease Weed Science Research Unit at Fort Detrick, Maryland. TCK can sometimes cause yield losses, but only if the conditions are optimum for infection to occur, he says.

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ARS Biologist and TCK Task Force member Gary L. Peterson prepares a presentation of the TCK Pest Risk Assessment Model.

Until recently, China, India, Mexico, and Brazil enforced restrictions on TCK in shipments of milling wheat, denying the U.S. wheat industry a sizeable grain export market, he notes. Agricultural officials in these countries feared that accepting U.S. grain shipments could introduce TCK into their domestic wheat crops.

Peterson is familiar with such issues because of his role on a TCK task force, comprising other U.S. and international researchers, wheat industry experts, and analysts. Created in 1997 by Wilda H. Martinez, ARS' North Atlantic Area director, and honored in June by USDA Secretary Dan Glickman, the task force scientifically backed U.S. trade negotiations to lift the wheat restrictions.

Unchecked by fungicide-treated seed or by cultivars possessing genetic resistance, TCK infection can stunt a plant's growth. Further, it converts the plant's developing seeds into "bunt balls"—encapsulated, powdery, black masses containing over 10 million teliospores, which are easily dispersed by wind and rain or mechanical harvest and transport.

"The nature of the U.S. grain transport system, with its continuous mixing of wheat lots destined for export terminals, results in low, but detectable, levels of TCK contamination of unaffected grain at the ports," says Peterson. The fungus, a plant pathogen, poses no human health risk.

Nonetheless, in 1973 China embargoed U.S. wheat shipments from the Pacific Northwest and enacted a zero-tolerance policy on TCK spores in American grain exports. That embargo lasted until April 1999, when a breakthrough agreement was signed with the United States. What was key to the negotiations? The TCK task force's 57-page, quantitative pest-risk assessment (PRA) presented by U.S. trade officials.

The heart of the report was a research-driven, quantitative PRA model showing a negligible risk of the fungus' spread to Chinese wheat, partly because of China's seasonal climate, TCK spore levels in U.S. wheat exports, and spore levels needed to induce disease. By easing its zero-tolerance policy to 30,000 TCK spores per 50 grams of grain, the United States–China agreement opened the door to $150 million worth of U.S. wheat exports.

The science that backed the agreement came from more than a decade's worth of research and collaboration. Martinez got the ball rolling in 1989, when she received ARS funding to address China's TCK concerns by providing scientific facts about the fungus, its genetic variability, geographic distribution, spore growth, spread, and virulence. The effort also scrutinized environmental, crop-production, processing, and distribution variables affecting the fungus' survival.

Peterson initiated and coordinated research to support the PRA, including a critical 3-year study in Utah and Montana with ARS plant pathologist Blair J. Goates, which showed that very high numbers of TCK spores must be deposited onto the soil surface for disease to occur. This fact established the basis for the TCK tolerance level in the current United States–China agreement.

Another key element was a "geophytopathological model" (GPM). Developed in cooperation with USDA meteorologist Robert J. Stefanski, the GPM gave scientists a tool for locating climatic regions favorable to TCK survival. It did this by correlating susceptible wheat infection stages with TCK's specific environmental requirements.

When applied to Brazil and Mexico, for example, the GPM showed that conditions simply didn't occur for TCK to thrive—namely, 45 days of uninterrupted moisture, temperatures of –2˚ to 10˚C, and mild winters under continuous snow cover. And when applied to China, the GPM showed that regions conducive to the fungus were few—and far from China's import terminals and mills, Peterson says.

Peterson also initiated a study at a Kansas State University-run grain mill to determine whether or not spores survived processing. Led by ARS scientist Don B. Bechtel, the study examined spore distribution in various milling fractions, including dust from filters.

Another study, funded by the U.S. Wheat Associates, looked at TCK spore levels in U.S. export ships. Along with ARS agricultural engineer Thomas B. Whitaker, in Raleigh, North Carolina,

Wheat spike infected by *Tilletia controversa* with glumes removed to expose fungal sori (bunt balls).

Inset: Healthy seed (left), intact fungal sorus, and crushed sorus releasing millions of dustlike *Tilletia controversa* teliospores.

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John B. Pitchford, of USDA's Grain Inspection, Packers, and Stockyards Administration, and the Wheat Market Center, Peterson set up a lab in Portland, Oregon, to monitor TCK grain levels for 7 years. This study became a major PRA component.

By drawing on substantial TCK data and a global weather network, task force members constructed a TCK risk-assessment computer-simulation model, now maintained by John G. Phillips of ARS' North Atlantic Area Office in Wyndmoor, Pennsylvania.

Peterson says the PRA model can estimate the risk of importing TCK-bearing grain by analyzing a recipient country's wheat-import profiles and meteorological and other data. It can also predict the effects of different scenarios, such as increased import levels, increased TCK spore export levels, or climate change.

"The model quantitatively assesses the probability that spores contained in a U.S. grain shipment will escape through various pathways from the ship to the mill, be deposited in a winter wheat field conducive to dwarf bunt, and germinate in sufficient numbers to cause infection," says Peterson.

The model's abilities also came in handy in successful USDA negotiations with Brazil. In April 1998, at APHIS' request, Martinez, Peterson, and Stefanski quickly drafted a TCK PRA report for Brazil. Then, Peterson and Stefanski presented their results to agricultural officials of Comite de Sanidada Vegetal del Cono Sur (COSAVE), which also represents Chile, Argentina, Uruguay, and Paraguay. At the time, Brazil was 2 years into a U.S. wheat embargo. And until that April meeting with the U.S. agricultural attaché, COSAVE officials had been considering a regional embargo as well. The end to Brazil's ban brought a key opportunity to begin exporting a projected 13 million bushels of U.S. wheat. Similar negotiations proved successful with India and Mexico, as well.—By **Jan Suszkiw,** ARS.

This research is part of New Uses, Quality, and Marketability of Plant and Animal Products, an ARS National Program (#306) described on the World Wide Web at http://www.nps.ars.usda.gov.

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